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Postharvest Handling
Technical Bulletin

PAPAYA

Postharvest Care and Market Preparation

Technical Bulletin No. 5

June 2003

POSTHARVEST HANDLING TECHNICAL SERIES

PAPAYA

Postharvest Care and Market Preparation

Ministry of Fisheries, Crops and Livestock
New Guyana Marketing Corporation
National Agricultural Research Institute

Technical Bulletin No. 5

June 2003

With the assistance of the United States Agency for International Development

Table of Contents

Preface 1

Introduction 2

Harvest Maturity Indices 2

Harvest Methods 3

Preparation for Market 5

A. Cleaning 5

B. Grading 5

C. Waxing 6

D. Packing 6

Temperature Management 7

Relative Humidity Management 7

Principal Postharvest Diseases 7

A. Anthracnose 7

B. Black Rot 8

C. Phytophthora Fruit Rot 9

D. Watery Soft Rot 9

E. Wet Fruit Rot 10

F. Stemphylium Fruit Spot 11

G. Alternaria Fruit Spot 11

Postharvest Disorders 12

A. Chilling Injury 12

B. Mechanical Damage 12

ANNEX I Publications in the Postharvest Handling Technical Bulletin Series 13

Preface

This publication is part of a series of technical bulletins that seek to provide specific recommendations for improvements in postharvest care and market preparation for selected non-traditional agricultural products. The intended audience for this series is primarily extension agents.

Initial market assessments in current export markets and visits with producers and exporters in Guyana have shown the quality of fresh produce currently exported is uneven and in some instances very poor. Stages all along the export chain from harvest and pre-harvest to transportation and final export are all in need of improvement. Pre-harvest practices, sanitation at the packinghouse, packaging, bacterial and fungal problems, and transportation were all identified as areas where improvement could benefit the quality and increase the shelf life of Guyana's fresh produce exports. The technical bulletins address these issues specific to each product. Harvesting techniques and crop maturity indices are provided. Preparation for market, including cleaning, sorting, packing and transportation are covered. The bulletins address and recommend specific storage conditions, covering temperature and humidity controls. Finally the bulletins address postharvest diseases and insect damage.

The undertaking of these technical bulletins is a joint effort of the Ministry of Fisheries, Crops and Livestock; the New Guyana Marketing Corporation (NGMC) and the National Agricultural Research Institute (NARI) to improve quality, increase production and promote exports. As a team, the three agencies are working on the problems, limitations, and constraints identified in the initial reconnaissance surveys, from production and postharvest handling problems, to packaging and transportation, to final market.

Introduction

The papaya (*Carica papaya*) is a popular fruit in Guyana, available throughout the year. Papaya trees begin to produce fruit within 9 months after transplanting, depending upon cultivar, production practices, and weather conditions. Several types of papayas are grown, ranging from the large elongated fruit type to the smaller pear-shaped Hawaiian type (Figure 1). The fruit is widely distributed in the domestic market and small volumes are exported to Barbados and Canada.

Harvest Maturity Indices

Various non-destructive indices can be used to determine papaya harvest maturity, including the number of days from flowering, fruit size, and external color. It is important to harvest papaya fruit at the proper maturity stage, because they do not increase in sugar content after picking.

Papayas normally require about 3 months from flowering until fruit maturity. The smaller pear-shaped Hawaiian type papaya fruit generally weigh between 350 to 500gm when mature. Native type fruit are significantly larger when mature, often weighing more than 1500 gm when mature. The most obvious index of fruit maturity is external skin color. As the fruit matures, the skin color will change from green to yellow/orange (Figure 2).

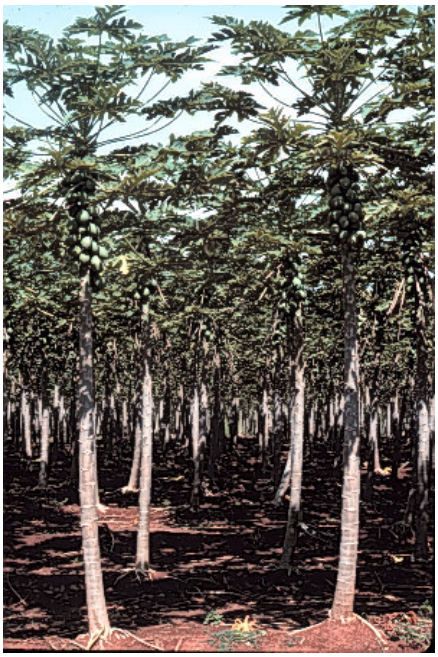
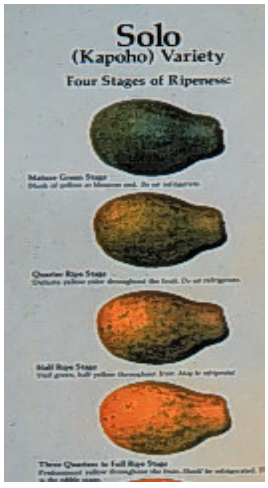


Figure 1. Hawaiian-type papayas nearing harvest maturity.



Papayas for export should be harvested between the one-stripe stage [one yellow stripe showing at the blossom end (Figure 3)] and the quarter-ripe stage [some yellow at the blossom end (Figure 4)]. Fruits harvested at these stages of maturity will withstand the rigors of shipping and transport to distant markets. Fruits harvested immature green will not ripen properly, will taste flat, and shrivel prematurely. For fruits to arrive in the importing country at the correct color stage, attention has to be paid to the maximum and minimum color stage on departure from Guyana, the length of transit, and the transit temperature. Many importers prefer fruits to arrive at the half-yellow color stage.

Figure 2. External skin color changes from green (top) to yellow-orange (bottom) during ripening.

Figure 3. Export market destined papaya fruits harvested at the one-stripe stage

Figure 4. Slightly yellow (quarter-ripe) papaya fruits destined for export.

Flavor and edible quality generally improve with advanced ripeness stage. Fruits intended for domestic markets can be harvested at a more advanced stage of ripeness than export market fruit. Domestic marketed fruits should be harvested when the skin is partially yellow-orange in color (between one-quarter to half-ripe). A completely yellow-orange skin indicates full ripeness and generally a sweeter fruit. However, the postharvest life of this advanced maturity stage fruits will typically be less than a week (Figure 5).

Destructive indices used for determining harvest maturity include internal pulp color and % soluble solids content (sugar content). These indices are used to test randomly selected fruits in order to correlate fruit size with maturity. The internal pulp color of mature papaya fruit changes from cream to yellow-orange as the external skin color changes from green to yellow-orange during ripening. The soluble solids content of mature fruits should be at least 11.5%, and can be determined by placing several drops of juice on a hand-held refractometer. Experienced growers use a combination of external and internal maturity indices to determine when to harvest.

Figure 5. Papaya fruits harvested at full ripeness (yellow-orange skin color) have a very short market life.

Harvest Methods

Papayas should be harvested during the coolest part of the day, which is typically in the morning. As the fruit temperature rises, it is more susceptible to bruising injury. Avoid harvesting during the heat of the afternoon. Papayas are harvested manually by hand, with a knife, or with a specialized cutting blade. When harvesting by hand or with a knife, the fruit is either snapped off or cut off the tree. If a portion of the stem is still

attached, it should be trimmed flush against the top of the fruit. Care is necessary to prevent staining of the fruit surface from the exudation of latex out of the cut stem end. When a ladder is required to reach the fruits on tall plants, the harvester typically tosses the fruit to another person standing below.

Papaya fruit is very sensitive to bruising and must be handled gently at all times. Fruits should not be allowed to drop to the ground, as this will soften and damage the pulp and scar the skin. Postharvest deterioration of dropped fruits will be rapid and brown spots will develop on the skin surface, lowering the market quality.

The initial sorting of marketable versus unmarketable fruits should be made in the field. Severely damaged or defective fruits should be put into a separate container and discarded in a location away from the papaya trees to minimize the build-up of disease inoculum in the area. The remaining marketable fruits, whether intended for local market or export, should be carefully placed in a strong, well-ventilated, padded, stackable field container. The field container should not hold more than 20 kg of fruit and should be put in a shaded area when full. Use of canvas sacks, non-padded reed baskets, or large volume field containers will result in considerable fruit bruising and skin injury. A better field container is a wooden crate or durable plastic container. Field containers which have a rough or uneven inside surface will scar the skin, especially when there is movement or vibration. This will result in uneven coloration of the skin as the fruits ripens. Skin abrasions result in blotchy coloration and green islands (areas of skin that remain green and sunken when the fruit is fully-ripe) and accelerated water loss (Figure 6).

Figure 6. Uneven skin coloration of bruise damaged papaya fruit.

The stem should be trimmed even with the shoulder of the fruit to prevent puncturing or surface abrasion of adjacent fruit. Field crates containing fruit should be put in a shaded area protected from the sun and rain, while awaiting collection for delivery to a packing facility. Care should be taken during transport to minimize fruit vibration in the field crates. Mesh bags, sacks, or baskets are unacceptable for papaya transport due to the high amount of bruising that would occur.

The fruits should be transported to a collection area or packinghouse soon after harvest. The crates should be carefully loaded and stacked in the transport vehicle in order to minimize handling damage to the fruits. There should be adequate ventilation through the field containers and the transport vehicle should have a protective cover over the crates of papayas. Ideally, the fruits should be transported during the coolest time of the day in order to minimize heat build-up inside the transport vehicle. Papayas are very sensitive to heat stress and bruise easily during transport when the fruits temperature is above 32°C (90°F). Bruised pulp becomes soft and deteriorates quickly. Upon arrival at the consolidation facility, the crates should be unloaded with care and never dropped. They

should be handled as little as possible to avoid unnecessary damage. The crates should be stacked in a shaded well-ventilated area.

Preparation for Market

Various steps should be followed in preparing papayas for market. These involve cleaning, grading, and packing. These operations should be carried out in an easily accessible, shaded area which is protected from rain.

Cleaning

Papaya fruits are generally not washed for the domestic market. If the fruits surface is stained or dusty it can be cleaned with a damp cloth or cotton gloves. Washing may be required to remove latex stains or enhance appearance for a particular market.

The wash water should be clean and properly sanitized to reduce the potential for spread of disease (Figure 7). A mild detergent may be added to the wash water to improve cleaning efficiency. Sodium hypochlorite (household bleach) is commonly used as the wash water sanitizing agent. It is effective against decay organisms when maintained at a concentration of 150 ppm and a water pH of 6.5 to 6.7. 150 ppm is equal to 2 oz of household bleach (such as Marvex) per 5 gallons of water, or .3 liters of bleach per 100 liters of water. The fungicide thiabendazole (TBZ) should also be added to the wash water at a 500 ppm concentration for postharvest disease control. As the wash water becomes contaminated with dirt particles and organic matter, the sanitizing ability of hypochlorous acid and the fungicidal activity of TBZ is diminished. Therefore, the wash water tank should be changed when necessary and filled with clean water containing hypochlorous acid and TBZ.

Figure 7. Cleaning of papayas in a chlorinated water tank prior to grading.

Grading

An essential step in market preparation is fruit selection or grading according to the standards required by the market. Grading should be carried out as soon as possible after harvest. Fruits should be carefully sorted according to size, shape, and external color. All fruit within the same market container should be uniform in size, shape, and skin color.

The quality standards for export grade fruits are considerably higher and more stringent than domestic grade fruit. Export quality fruits must be free of bruises, latex burn, skin blemishes, insect damage, physical injury, surface scars, and disease. Shriveled and discolored fruit should be eliminated. The fruits should be firm and at the one-stripe stage to quarter-yellow in skin color in order to withstand the rigors of air transport and inland distribution in the destination country.

Waxing

Application of a surface wax will help reduce shrinkage and give the fruits a glossy appearance. Several types of waxes, generally carnauba or shellac based formulations, work well on papaya.

Packing

Fruits should be separated and packed according to size or weight, resulting in different individual fruit counts in a container. Papayas sold in the domestic market should be packed in strong, well-ventilated wooden or fiberboard containers. They should be padded on the inside if the inner surface of the container is rough. Packing fruits in weak cartons that do not stack will result in substantial surface scarring and eventual postharvest decay.

Export market fruits should be packed in strong, well-ventilated fiberboard cartons. North American and European markets typically prefer papayas packed in a single-layer carton with a net weight of 4 or 4.5 kg (9 or 10 lb). The most commonly used packaging materials are one-piece self-locking or two-piece full telescopic fiberboard cartons with a minimum bursting strength of 275 lb/in^2. A thin cushion of foam or shredded paper is often put in the base of the carton to minimize surface abrasion and vibration injury during transport. Cartons of pear-shaped Hawaiian types are usually packed with 8 to 16 uniformly sized fruit per carton (Figure 8). Individual fruits are often wrapped in soft tissue paper to minimize surface abrasion during transport. Individual labels can be attached to the fruits for market recognition.

Figure 8. Single layer of 10-count papayas packed in a fiberboard carton for export.

The following size classification, fruit weight range, and fruit count is typically used for a 4 kg net weight carton:

- Small; 260 to 360 g; 12 to 15 count
- Medium; 360 to 550 g; 8 to 12 count
- Large; 550 to 1000 g; 4 to 8 count

Most importers prefer small to medium sized fruits. Large fruit is popular among importers who supply the specialty and catering markets.

Temperature Management

The ideal storage temperature for maximum shelf life of papaya is 10°C (50°F). Above this temperature the fruits will ripen more quickly and become soft. Below this temperature the fruits will not ripen properly and break down due to the physiological disorder known as chilling injury. Postharvest life depends on the stage of harvest maturity, but typically ranges from 1 to 3 weeks.

Fruits harvested at the one-stripe stage and held under ambient tropical conditions (25°C to 28°C or 77°F to 82.5°F) will ripen to 60% to 70% yellow coloration within four to six days. Fruits transferred to low temperature storage (10°C) when harvested at the one-stripe stage will store successfully for 14 to 21 days if postharvest disease can be controlled. When harvested at more advanced stages of ripening, the storage life will be significantly reduced. Fruits harvested three-quarters ripe (yellow-orange) and held at ambient temperatures will have a maximum market life of only 5 to 6 days.

Relative Humidity Management

Papayas are high in water content and susceptible to postharvest shriveling. In order to minimize weight loss and desiccation of the skin, the fruit should be stored under high relative humidity (RH) conditions. The ideal postharvest environment for holding papayas is between 90% to 95% RH.

Principal Postharvest Diseases

Anthracnose

Anthracnose, caused by the fungus *Colletotrichum gloeosporiodes*, is a serious postharvest disease of papaya. The pathogen initially infects intact, non-wounded, immature green fruit in the field. However, symptom development generally occurs after harvest, especially when the fruit is ripe. Disease symptoms begin as small water-soaked spots on ripening fruits. As the spots develop, they become sunken and turn brown or black and may enlarge to 2 in. (5 cm) in diameter (Figure 9). The fungus may produce a pink mass of spores in the middle of these older spots. The pathogen can grow into the fruits, resulting in softening of the tissue and an off flavor of the pulp.

The environmental conditions that favor the pathogen are high temperatures (optimal is 28°C) and high humidity. Disease spores must have free water to germinate and are spread by wind or rain. Anthracnose can be controlled by following an adequate fungicide spray program beginning at fruit set and continuing at regular intervals (usually every 10 to 14 days) while the plants are producing fruit.

Postharvest application of the fungicide thiabendazole (1000 ppm spray or dip) is effective in reducing the amount of anthracnose decay. Also, a postharvest hot water dip at 48°C for 20 minutes will significantly reduce the amount of anthracnose. Specialized

equipment is needed for circulating the water and maintaining a uniform temperature, as fluctuations in water temperature will reduce the effectiveness of the treatment and may damage the fruits.

Although no known cultivar of papaya offers complete resistance to anthracnose, the Hawaiian cultivar Sunrise is more resistant than is Kapoho.

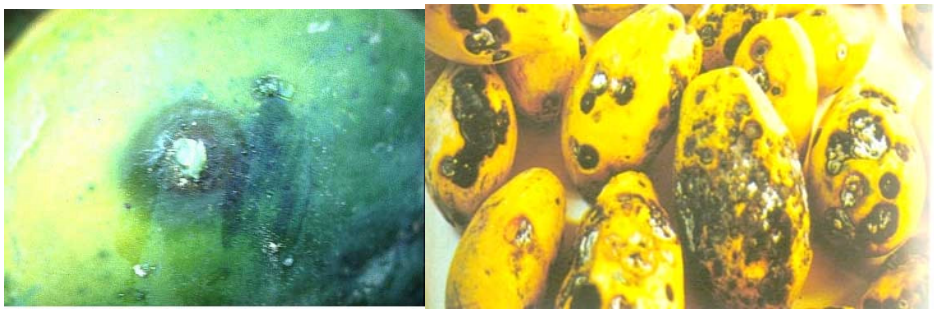


Figure 9. Anthracnose decay of mature green (left) and ripe (right) papaya fruit.

Black Rot

Black rot, caused by the fungus *Mycosphaerella caricae*, is another common postharvest disease of papayas. Fruits symptoms may appear in several different ways. Slightly sunken circular surface lesions may appear anywhere on the fruit, eventually enlarging up to 4 cm in diameter (Figure 10). The margin of the lesions are light brown and translucent. As the lesion surface dries and wrinkles with age, it turns black and becomes covered with fungal growth. The infected tissue usually remains firm. Another typical symptom of black rot is a dry, firm, dark rot extending into the fruit from the stem end (Figure 10).

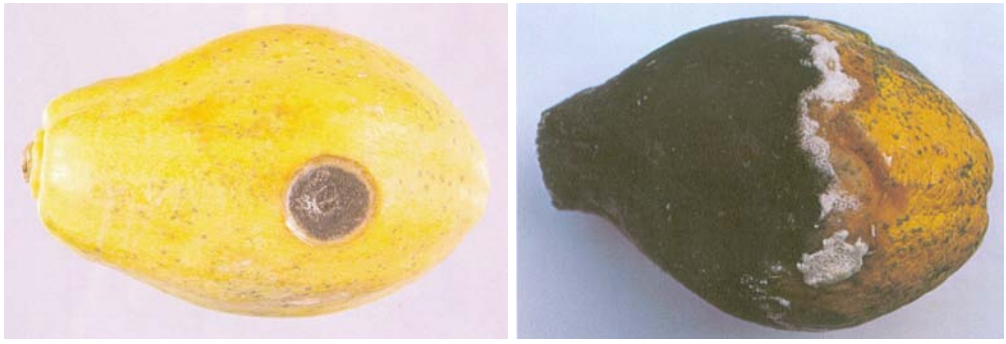


Figure 10. Sunken lesion (left) and stem end decay (right) of black rot infected papaya.

The fungus colonizes senescing leaves and petioles that serve as the primary source of inoculum in the field. The disease is spread by rain and may remain dormant on the fruit surface for extended periods. Wounds created during harvest and postharvest handing may be quickly infected with the pathogen under ambient temperatures. The incidence of

postharvest stem-end rot on fruit from non-sprayed fields is typically between 30 to 40% of the total harvest.

A significant reduction in stem-end rot is obtained by biweekly fungicide sprays during fruit growth and development. A postharvest hot water treatment at 48°C for 20 minutes also significantly reduces stem-end rot. Fruits should be treated within a day after harvest.

Phytophthora Fruit Rot

Heavy fruit losses caused by the fungus *Phytophthora palmivora* frequently occur during rainy periods. When mature fruits are infected, circular translucent lesions develop on the skin and become covered with a whitish to gray fungal growth (Figure 11). Rain and wind are the two principal ways of spreading Phytophthora in the field. Temperature also influences disease severity, with pathogen growth being highest at 25°C.

Figure 11. Whitish fungal growth on mature papaya fruit infected with Phytophthora rot.

Phytophthora fruit rot can be controlled with bi-weekly preventive fungicides, such as mancozeb, basic copper sulfate, Ridomil, or Aliete during fruit growth. Cultural practices are also important in the management of Phytophthora. The disease incidence on mature trees during rainy periods can be greatly reduced by improving drainage in orchards. Infected fruit on trees and on the ground should be removed.

Watery Soft Rot

Watery soft rot, caused by the fungus *Rhizopus stolonifer*, is a common postharvest disease of papayas. It is important only during fruit storage and transit and is rarely seen in the field. When Rhizopus infects fruit already packed for market, the watery leakage causes an unsightly mess. Watery soft rot is characterized by a soft and watery rot that quickly causes the collapse of the entire fruit but leaves the cuticle intact (Figure 12). The fungus can grow through any break in the cuticle and spread rapidly to adjacent fruit, often destroying the entire contents of a box within a few days. The infected fruit is often covered by a coarse gray to black hairy fungal mass. The affected fruits quickly becomes colonized by yeasts and bacteria and have a sour odor.

Figure 12. Typical symptoms of watery soft rot.

Rhizopus can enter the fruit tissue only through wounds and cannot penetrate uninjured fruit surfaces. Therefore, wounding that occurs during harvesting, transporting, or postharvest handling plays an important role in the development of the disease.

The incidence of watery soft rot increases during rainy weather, in part because of higher inoculum levels, higher humidity, and an increase in the number of fruit lesions caused by other fungi. High humidity and temperatures of about 25°C during storage or transit are optimum for Rhizopus soft rot development.

The most important control measure is sanitation in and around the packing plant. Rotting fruit in packing plants should be removed and destroyed. Bins and water tanks used for fruits should be chlorinated to prevent the buildup of this and other pathogens. Conveyor belts, rollers, and other equipment that touch the fruit should be regularly sanitized.

Preventive field fungicide sprays control Rhizopus soft rot by reducing field inoculum levels.

Wet Fruit Rot

Wet fruit rot is caused by the fungus *Phomopsis*, and in its early stages resembles Rhizopus watery soft rot. It occurs most frequently as a stem-end rot, although any part of the fruit can be affected. Symptoms include a discoloration of the tissue around the stem end, which soon breaks down and becomes colonized by a whitish-gray mold (Figure 13). The fungus grows rapidly, causing lesions to expand very quickly and extend into the seed cavity. The cuticle over the infected area remains intact and develops a delicate, is soft, mushy, and wet but, unlike tissue affected by Rhizopus watery soft rot, does not usually leak liquids. Wounding of the fruits is required for infection. The disease usually develops on fully ripened fruit and is rare on green fruits in the field.

Figure 13. Phomopsis stem-end rot on ripe papaya fruit.

Control of wet fruit rot, like the control of many other postharvest diseases of papaya, must begin in the field. Regular field sprays with protective fungicides reduce inoculum levels and prevent infection through wounds that might occur in the field. Dead leaves should be removed from trees because they may become heavily infected with *Phomopsis* and interfere with spraying. The removal of leaves is best accomplished by periodically cutting the petioles that droop below horizontal about 30cm from the stem and removing them about a week later after the abscission zone forms but before the petiole stub has dried.

The prevention of mechanical wounds during and after harvest is important. Postharvest hot water treatment for 20 min at 48°C is also effective when used in conjunction with regular field preventive sprays.

Stemphylium Fruit Spot

Early symptoms of Stemphylium fruit spot are development of small, round, dark brown surface lesions. The lesions become sunken and develop reddish brown to purple margins as they enlarge. A velvety, dark green spore mass forms in the lesion center. White to gray fungal growth covers the lesion in advanced stages. Internally, the infected tissue is discolored from reddish brown to dark brown, appears dry, and may develop small air pockets.

The Stemphylium fungus is also capable of causing decay of the stem end. The characteristics of decay of the stem end are similar to those of the fruit spot, except infection begins on the broken-end surface or near the base of the stem and later spreads to the surrounding tissue.

Regular field sprays with protective fungicides help keep the inoculum level low in the field. The standard single hot water dip is effective in controlling this disease. Hot water exposure at 48°C for 20 min will kill more than 98% of the conidia. Wounding and prolonged cold storage should be avoided, and heat-treated fruit should be cooled immediately after treatment. Injury or stress, wounds, and chilling injury all increase the susceptibility to fruit spot. Ripe fruits are the most likely to be infected.

Alternaria Fruit Spot

Alternaria fruit spots are depressed, circular to oval lesions that eventually become black as a result of pathogen sporulation. Lesions are restricted to the surface of the fruit and do not cause extensive rotting of the flesh. However, lesions from multiple infection sites can coalesce as they expand and eventually cover the entire fruit surface.

Alternaria fruit spot rarely develops on fruits kept or ripened at room temperature. However, fruits that are kept in cold storage (< 10°C) for 10 to 14 days will suffer chilling injury and a high incidence of Alternaria.

The fungicides chlorothalonil or mancozeb will significantly reduce postharvest Alternaria development if sprayed biweekly during fruits growth. However, a preharvest spray program alone does not provide complete control of this disease. A single postharvest hot water dip of 20 min at 48°C also will reduce the disease.

Postharvest Disorders

Chilling Injury

Papayas are susceptible to chilling injury (CI) if held below 10°C. The amount of damage is greater at lower temperatures and longer durations of exposure. Symptoms of CI soon appear after the chilled fruits are returned to ambient temperatures for marketing.

Figure 14. Chilling injured papaya fruit infected with Alternaria rot.

Typical CI symptoms include the development of sunken lesions on the skin surface (pitting), discoloration of the peel and the flesh, incomplete ripening, poor flavor and increased susceptibility to postharvest decay (Figure 14). Susceptibility to chilling injury varies between cultivars and is greater in mature-green than ripe papayas.

Mechanical Damage

Damage to the skin after harvest will result in latex staining, punctures, scars and bruises (Figure 15). During ripening, bruised areas will develop into dark soft regions which become affected by secondary microbial infection. Similar effects can occur as a result of poor handling during washing, grading and packing. Damage can be reduced by taking protective measures throughout the handling procedures. This includes avoiding the dropping of fruits, over-filling of field containers, and excess movement of fruits during transport. Padding should be put in the bottom of the field containers and the fruits should not be piled more than one layer high without a protective divider. Stems should be removed in the field to prevent puncturing or scratching of adjacent fruits. Vehicles used to transport the fruits from the field to packinghouse should be driven slowly and with care. Transport of ripe fruits (more than 50% yellow color) is not recommended due to the susceptibility to mechanical damage and bruising. During handling in the packinghouse, fruits should never be thrown or dropped and in automated operations, all machinery should be padded where possible.

Figure 15. Symptoms of mechanical damage on ripe papaya fruit.

ANNEX I

PUBLICATIONS IN THE POSTHARVEST HANDLING TECHNICAL BULLETIN SERIES

PH Bulletin No. 1	Pineapple: Postharvest Care and Market Preparation, November 2002.
PH Bulletin No. 2	Plantain: Postharvest Care and Market Preparation, June 2003.
PH Bulletin No. 3	Mango: Postharvest Care and Market Preparation, June 2003.
PH Bulletin No. 4	Bunch Covers for Improving Plantain and Banana Peel Quality, June 2003.
PH Bulletin No. 5	Papaya: Postharvest Care and Market Preparation, June 2003.
PH Bulletin No. 6	Watermelon: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 7	Peppers: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 8	Oranges: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 9	Tomato: Postharvest Care and Market Preparation, October 2003.
PH Bulletin No. 10	Okra: Postharvest Care and Market Preparation, October 2003.

PLANNED PUBLICATIONS - 2004

Cassava: Postharvest Care and Market Preparation.

Eggplant (Boulanger): Postharvest Care and Market Preparation.

Lime: Postharvest Care and Market Preparation.

Sweet Potato: Postharvest Care and Market Preparation.

Yam: Postharvest Care and Market Preparation.

Ginger: Postharvest Care and Market Preparation.

Pumpkin: Postharvest Care and Market Preparation.

Harvest Maturity Indices

Papayas require about 3 months from flowering to fruit maturity. The main measure of harvest maturity is skin colour. Immature fruit are entirely green in colour. As the fruit matures, streaks of yellow appear at the blossom end. At this stage, the fruit is mature but not fully ripe. The fruit will continue to turn yellow, eventually ripening to a completely yellow or yellow/orange colour.

Fruit harvested at the immature green stage will not ripen properly, will taste flat, and shrivel too early. Flavour and taste improve as the fruit turns more yellow in colour, but firmness decreases. Fruit intended for the domestic market can be harvested at a more mature stage than export market fruit.

Domestic marketed fruit should be harvested when the skin colour is between one-quarter to one-half yellow. Fruit harvested at the full yellow or yellow/orange colour stage will be highest in sugar content, but the texture will be soft. Fruit harvested at this stage is too soft and bruises easily during transport.

Papayas for export should be harvested between the one-stripe stage (one yellow stripe showing at the blossom end) and the quarter-ripe stage (some yellow at the blossom end). Fruit harvested at these stages will be able to withstand the transport to distant markets.

When transporting fruit, it is important to note colour of the fruit, how long the fruit will be in transit, and the temperature at which the fruit will be stored during transit to ensure that the fruit arrives at the export market in the correct state of maturity. Many importers prefer fruit to arrive at the half-yellow colour stage.

Destructive measurements used for determining harvest maturity include internal pulp colour and % soluble solids content (sugar content). These indices are used to test randomly selected fruit in order to compare fruit size with maturity. The internal pulp colour of mature papaya fruit changes from cream to yellow-orange as the external skin colour changes from green to yellow-orange. The soluble solids content of mature fruit should be at least 11.5%, and can be determined by placing several drops of juice on a hand-held refractometer.

Harvest Methods

Papayas are harvested manually by hand, with a knife, or with a specialized cutting blade. When harvesting by hand or with a knife, the fruit is either snapped off or cut off the tree. If a portion of the stem is still attached, it should be trimmed closely against the top of the fruit. Latex out of the cut stem end can cause staining of the fruit surface.

Papaya fruit is very sensitive to bruising and must be handled gently at all times. Fruit should not be allowed to drop to the ground, as this will cause bruising and brown spots, soften the pulp and increase chances of postharvest decay. Papayas should be harvested during the coolest part of the day. As the fruit temperature rises, it is easier to bruise.

The first sorting of marketable versus unmarketable fruit should be made in the field. Severely damaged or defective fruit should be put into a separate container and thrown out in a location away from the papaya trees to minimize the build-up of disease prone materials in the area. The remaining marketable fruit, whether intended for local market or export, should be carefully placed in a strong, well-ventilated, padded, stackable field container. The field container should not hold more than 20 kg (44 lb) of fruit and should be put in a shaded area when full. Use of canvas sacks, non-padded reed baskets, or large volume field containers will result in considerable fruit bruising and injury. Wooden crates or durable plastic containers are better field containers. Field containers that have a rough or uneven inside surface will scrape the skin and will result in uneven coloration of the skin as the fruit ripens.

Preparation for Market

Cleaning

If the fruit surface is not very dirty it can be cleaned with a damp cloth or cotton gloves. Washing may be required to remove latex stains or enhance the appearance for a particular market. The wash water should be clean and properly sanitized to reduce the spread of disease. A mild detergent may be added to the wash water to improve cleaning efficiency. Hypochlorous acid (household bleach) is commonly used as the wash water-sanitizing agent. It is effective against decay organisms when maintained at a concentration of 150 ppm and a water pH of 6.5. This is equal to 2 oz of household bleach (such as Marvex) per 5 gallons of water, or .3 liters of bleach per 100 liters of water. The fungicide thiabendazole (TBZ) should also be added to the wash water at a 500 ppm concentration for postharvest disease control. Follow manufacturer's instructions for using fungicides. Also, the wash water tank should be changed when necessary and filled with clean water containing hypochlorous acid and TBZ.

Grading

Fruit should be carefully sorted according to size, shape, and external colour. All fruit within the same market container should be identical in size, shape, and skin colour. Export fruit must not have bruises, latex burn, skin blemishes, insect damage, physical injury, surface scars, or disease. Shriveled and discoloured fruit should be discarded. The fruit should be firm and at the one-stripe stage to quarter-yellow in skin colour.

Waxing

Application of a surface wax will help reduce shrinkage and give the fruits a glossy appearance. Several types of waxes, generally carnauba or shellac based formulations, work well on papaya.

Packing

Fruit should be separated and packed according to size or weight, which will result in different fruit counts in containers. Papayas sold in the domestic market should be

packed in strong, well-ventilated wooden or fiberboard containers. They should be padded on the inside if the inner surface of the container is rough.

Export market fruit should be packed in strong, well-ventilated fiberboard cartons. North American and European markets usually prefer papayas packed in a single-layer carton with a net weight of 4 kg or 4.5 kg (9 lb or 10 lb). A thin cushion of foam or shredded paper is often put in the base of the carton to minimize surface scratching and injury during transport. Cartons of pear-shaped Hawaiian types are usually packed with 8 to 16 uniformly sized fruit per carton. Individual fruit are often wrapped in soft tissue paper to minimize surface damage during transport.

The following size classification, fruit weight range, and fruit count is typically used for a 4 kg net weight carton:

- Small; 260 - 360 g (½ lb to ¾ lb); 12 to 15 count,
- Medium; 360 - 550 g (¾ lb to 1 lb) ; 8 to 12 count,
- Large; 550 - 1000 g (1 lb to 2 lbs); 4 to 8 count.

Temperature Management

The best storage temperature for maximum shelf life of papaya is 10°C (50°F). Fruit stored above this temperature will ripen more quickly and become soft. Postharvest life depends on the stage of harvest maturity, but typically ranges from 1 to 3 weeks. Fruit harvested at the one-stripe stage and held under average conditions will ripen to 60% to 70% yellow colouration within four to six days. Fruit harvested at the one-stripe stage and held at 10°C will store for 14 to 21 days. When harvested at more advanced stages of ripening, the storage life will be significantly reduced.

Papayas are susceptible to chilling injury (CI) if held below 10°C (50°F) The amount of damage is greater at lower temperatures and longer durations of exposure. Typical CI symptoms include the development of sunken spots on the skin surface (pitting), discoloration of the peel and the flesh, incomplete ripening, poor flavor and increased vulnerability to postharvest decay.

Papayas are high in water content and can shrivel easily. During storage and transportation, the best relative humidity (RH) for papayas is between 90% and 95%.

Principal Postharvest Diseases

Papayas are vulnerable to a number of postharvest diseases. Decay can be controlled by good pre-harvest sanitation, careful harvesting and handling practices to minimize injury to the fruit, sanitized wash water, and maintaining the fruit at 10°C.

Anthracnose

Anthracnose disease symptoms begin as small water-soaked spots on ripening fruit. As the spots develop, they become sunken and turn brown or black and may enlarge to 0.5 cm (2 ins) in diameter.

Black Rot

The slightly sunken circular surface spots of black rot may appear anywhere on the fruit, eventually enlarging up to 4 cm in diameter. The outline of the spots is light brown and clear. As the spot surface dries and wrinkles with age, it turns black and becomes covered with fungal growth. The infected tissue usually remains firm. Another symptom of black rot is a dry, firm, dark rot extending into the fruit from the stem end.

Watery Soft Rot

A soft and watery rot that causes the collapse of the entire fruit but leaves the cuticle intact characterizes watery Soft Rot. The infected fruit is often covered by a coarse gray to black hairy fungal mass.

Technical bulletins are also available on waxing fruits and vegetables and hot bath treatment. Contact:
New Guyana Marketing Corporation (NGMC)
87 Robb & Alexander Sts., Georgetown, Guyana
Tel: 226-8255, 226-2219

National Agricultural Research Institute (NARI)
Mon Repos, East Coast Demerara, Guyana; Tel 220-2950

With the assistance of
The United States Agency for International Development

New Guyana Marketing Corporation

PAPAYA

Postharvest Care and Market Preparation Information Sheet

This information sheet provides growers and agriculture extension personnel with a summary of the recommended harvest and postharvest handling practices for papaya. A more technical and detailed bulletin is available from the New Guyana Marketing Corporation (NGMC) and the National Agricultural Research Institute (NARI).